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Shinji Yamamori, et al.

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For: CARBON DIOXIDE SENSOR AND AIRWAY ADAPTER INCORPORATED IN THE SAME

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STATEMENT UNDER 37 C.F.R. 1.55(a)

Sir,

I, Mitsuhiro Tsuchiya, hereby declare that I am conversant with both English and Japanese languages, and certify to best of my knowledge and belief that the attached are true and correct English translation of Japanese Patent Application No. 2003-147890 filed May 26, 2003.

Mitsuhiro Tsuchiya

Date: September 25, 2006

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This is to certify that the annexed is a true copy of the following application as filed with this Office.

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[Title of the Invention] Sensor for Measuring Carbon Dioxide

[Claims]

[Claim 1]

A carbon dioxide measurement sensor for measuring the concentration, partial pressure, or presence/absence of carbon dioxide in an expired gas of a living body, the sensor comprising:

light-emitting means and light-receiving means, which are axially disposed so as to oppose each other;

a support member for supporting said light-emitting means and said light-receiving means;

an expired gas passage which is provided in said support member and enables said expired gas to cross said optical axis when said support member is attached to a location below nostrils of said living body;

a horizontal shaft disposed at a position below said support member; and

a mouth guide which is supported by said horizontal shaft and pivotable back and forth with reference to the mouth of said living body, a portion of said mouth guide opposing the face of said living body being wholly formed into a smooth recess, and said recessed portion being in communication with said expired gas passage.

[Claim 2]

The carbon dioxide measurement sensor according to claim 1, wherein said horizontal shaft is formed integrally with said mouth guide and engaged with a hole formed in said support member.

[Claim 3]

The carbon dioxide measurement sensor according to claim 2, wherein said mouth guide is formed from a soft material, and said horizontal shaft is inserted into said hole through clearance fitting.

[Claim 4]

The carbon dioxide measurement sensor according to claim 2, wherein said hole is embodied as two holes, and said horizontal shaft is embodied as two shafts; and wherein said holes and said horizontal shafts are formed such that, when said horizontal shafts are engaged with said holes, neighborhoods of said holes of said support member and neighborhoods of said horizontal shafts of said mouth guide press against each other in said axial direction of said horizontal shafts by means of resilience of said mouth guide and/or that of said support member.

[Claim 5]

The carbon dioxide measurement sensor according to any one of claims 2 through 4, wherein said support member has a wall which protrudes downward therefrom exclusive of an area of said support member opposing said face; said protruding wall defines, in an area of said protruding wall opposing said face, a communication path remaining in communication with said expired gas passage, and said hole is formed in said protruding wall in a horizontal direction parallel to said face of said living body.

[Claim 6]

A carbon dioxide measurement sensor for measuring the concentration, partial pressure, or presence/absence of carbon dioxide in an expired gas of a living body, the sensor comprising:

light-emitting means and light-receiving means, which are axially disposed so as to oppose each other;

a support member for supporting said light-emitting means and said light-receiving means;

an expired gas passage which is provided in said support member and enables said expired gas to cross said optical axis when said support member is attached to a location below nostrils of said living body;

an oxygen supply tube for supplying oxygen; and

a latch member for latching said oxygen supply tube on said support member, wherein

prongs of said oxygen supply tube are of such a length that said prongs are not inserted into nostrils of a living body while said oxygen supply tube is latched by said latch member, and said prongs are arranged such that said oxygen supplied from said prongs is not ejected directly into said nostrils of said living body.

[Claim 7]

A carbon dioxide measurement sensor for measuring the concentration, partial pressure, or presence/absence of carbon dioxide in an expired gas of a living body, the sensor comprising:

light-emitting means and light-receiving means, which are axially disposed so as to oppose each other;

a support member for supporting said light-emitting means and said light-receiving means;

an expired gas passage which is provided in said support member and enables said expired gas to cross said optical axis when said support

member is attached to a location below nostrils of said living body; and

a latch member for latching an oxygen supply tube on said support member, wherein

said latch member is configured such that, when said oxygen supply tube is latched by said latch member, oxygen supplied from prongs of said oxygen supply tube is not ejected directly into said nostrils.

[Claim 8]

The carbon dioxide measurement sensor according to claim 6 or 7, further comprising:

a horizontal shaft disposed at a position below said support member; and

a mouth guide which is supported by said horizontal shaft and pivotable back and forth with reference to the mouth of said living body and whose area opposing said face of said living body is wholly formed into a smooth recess, wherein said recessed portion remains in communication with said expired gas passage.

[Claim 9]

The carbon dioxide measurement sensor according to any one of claims 1 through 5 or claim 8, further comprising:

a nasally-expired gas inlet member which is disposed on an upper portion of said support member and inserted at one end thereof to said nostrils for guiding the nasally-expired gas from said nostrils to said expired gas passage and at the other end thereof to said expired gas passage; and wherein a vent for bringing the inside of said expired gas inlet member into communication with the outside is formed in an area of said nasally-expired

gas inlet member, said area being located in the vicinity of a node between said nasally-expired gas inlet member and said expired gas passage.

[Claim 10]

The carbon dioxide measurement sensor according to claim 9, wherein said nasally-expired gas inlet member is constituted of a pair of tubes, and a merge section where passages of said pair of tubes merge at a portion of said merge section close to said support member and remain in communication with the expired gas passage; and wherein said vent is formed in an exterior wall defining said merge section.

[Claim 11]

The carbon dioxide measurement sensor according to claim 9 or 10, wherein said vent is provided in a location where discharge of a gas in said expired gas passage to the outside from said vent is not less likely to be affected by said living body when said carbon dioxide measurement sensor is attached to said living body.

[Claim 12]

The carbon dioxide measurement sensor according to any one of claims 9 through 11, wherein

said vent is provided in a position where said vent does not oppose said living body when said carbon dioxide measurement sensor is attached to said living body.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a sensor for measuring carbon

dioxide in an expired gas which measures the concentration, partial pressure, or presence/absence of carbon dioxide in a gas expired through the nostrils or mouth of a living body.

[0002]

[Conventional Art]

In general, when the concentration of carbon dioxide contained in a gas expired from a living body is optically measured, the expired gas is led through a cylindrically-shaped airway adapter. An infrared ray is radiated onto the expired gas from a light-emitting element. The amount of light that remains after some of the light has been absorbed by the carbon dioxide contained in the expired gas is detected by means of a light-receiving element, thus measuring the concentration of carbon dioxide.

[0003]

Fig. 16 shows the schematic configuration of an example of such a conventional apparatus for measuring the concentration of carbon dioxide. In Fig. 16, one end 101a of an airway adapter 101—which is formed into a substantially cylindrical shape and through which an expired gas passes—is to be connected to a tube inserted into an airway of a patient. Another end 101b is to be connected to a Y piece of a respiratory circuit, such as a respirator. An intermediate portion of the airway adapter 101 has a rectangular cross-sectional profile. Circular windows 101c, 101d are formed in respective, mutually-opposing surfaces of the intermediate portion such that the windows are concentrically aligned with each other.

[0004]

A sensor main unit 102 is formed into a substantially-rectangular

shape, and a U-shaped notch is formed in an intermediate portion of the sensor main unit 102, wherein the intermediate portion of the airway adapter 101 is to be fittingly attached to the notch. Two mutually-opposing surfaces remain in contact with the windows 101c, 101d of the airway adapter 101. A light-emitting element 103 is disposed on one side with reference to the notch formed in the sensor main unit 102.

[0005]

An optical filter 104 for absorbing light of only the wavelength to be absorbed by carbon dioxide and a light-receiving element 105 are disposed on the side opposite the light-emitting element 103 with reference to the notch formed in the sensor main unit 102. The light-emitting element 103 and the light-receiving element 105 are connected to a monitor main unit 107 via a lead wire 106. Incidentally, the intermediate portion of the airway adapter 101 is removably attached to the sensor main unit 102.

[0006]

In the conventional apparatus having the foregoing configuration, the light emitted from the light-emitting element 103 enters the light-receiving element 105 by way of the window 101c, the expired gas contained in the airway adapter 101, the window 101d, and the filter 104. The light-receiving element 105 detects the remaining quantity of light after some of the light has been reduced in accordance with the concentration of carbon dioxide. A signal output from the light-receiving element 105 is input to the monitor main unit 107, where the concentration of carbon dioxide is displayed.

[0007]

In the conventional example, the airway adapter 101 through which

an expired gas passes is attached to the sensor main unit 102. Another known conventional example has a structure in which a sampling tube is connected to a sensor main unit disposed in a monitor main unit.

[0008]

In the other conventional example, one end of the sampling tube which absorbs a portion of an expired gas is connected to an airway adapter through which the expired gas passes. The other end of the sampling tube is connected to the monitor main unit. A pump is disposed in the monitor main unit, and an expired gas is led to the sensor main unit disposed in the monitor main unit.

[0009]

Moreover, as shown in Fig. 17, an apparatus capable of measuring the concentration of carbon dioxide in an orally-expired gas as well as the concentration of carbon dioxide in a nasally-expired gas has also been proposed (see, e.g., Patent Document 1).

[0010]

The thus-proposed apparatus has a breathing gas collector 110, and this breathing gas collector 110 has a nasal canula 111 for collecting a nasally-breathed gas; an externally-convex mouth guide 113 for collecting an orally-breathed gas; an oral gas collecting member 114 which is disposed in the mouth guide 113 and collects an orally-breathed gas; and a joint system 112 which is connected at one end thereof to an external upper portion of the mouth guide 113 and at the other end thereof to the nasal canula 111.

[0011]

[Patent Document 1] United States Patent No. 5,046,491

[0012]

[Problems to be Solved by the Invention]

However, the conventional breathing gas collector 110 (see Fig. 17) involves a large number of components, because the joint system 112 is constituted of separate members. Further, the joint system 112 must be attached to two points; that is, the mouth guide 113 and the nasal canula 111. This entails consumption of man-hours and, by extension, costs.

[0013]

Further, in order to cause an expired gas to flow through an expired gas passage provided in the upper portion of the mouth guide, in the conventional breathing gas collector 110 the orally-breathed gas collection member 114 is disposed in the mouth guide 113. Hence, the orally-breathed gas collection member 114 exerts circulation resistance, which inhibits efficient flow of the orally-breathed gas through the expired gas passage.

When oxygen is also supplied in conjunction with collection of the expired gas, an oxygen supply tube is also attached to the patient. In the conventional oxygen supply tube, prongs are to be inserted into nostrils. Alternatively, even in the case of an oxygen supply tube which does not entail insertion of the prongs into the nostrils, the prongs are oriented so that oxygen supplied by way of the prongs is ejected directly toward the nostrils, which induces a problem of abrupt drying of the nostrils, causing the patient discomfort.

[0014]

The present invention has been conceived in view of the foregoing drawbacks and aims at resolving a technical challenge; that is, provision of a

carbon gas measurement sensor which can efficiently feed an expired gas to an expired gas passage located at an upper portion of a mouth guide; which can adjust the position of the mouth guide in accordance with the shape or size of a face; and which enables inexpensive manufacture of the sensor by means of minimizing the number of components and man-hours.

Moreover, another technical challenge to be met is to prevent direct emission to nostrils of oxygen supplied from prongs, in order to prevent abrupt drying of the nostrils.

[0015]

[How to Solve the Problem]

The present invention is characterized by providing a carbon dioxide measurement sensor for measuring the concentration, partial pressure, or presence/absence of carbon dioxide in an expired gas of a living body, the sensor comprising: light-emitting means and light-receiving means, which are axially disposed so as to oppose each other; a support member for supporting the light-emitting means and the light-receiving means; an expired gas passage which is provided in the support member and enables the expired gas to cross the optical axis when the support member is attached to a location below nostrils of the living body; a horizontal shaft disposed at a position below the support member; and a mouth guide which is supported by the horizontal shaft and pivotable back and forth with reference to the mouth of the living body, a portion of the mouth guide opposing the face of the living body being wholly formed into a smooth recess, and the recessed portion being in communication with the expired gas passage (Claim 1).

[0016]

According to the invention, the mouth guide is pivoted about the horizontal shaft, whereby the position of the mouth guide can be adjusted along the geometry of the face. Even when the geometry or size of the face of the living body varies drastically from that corresponding to the current configuration, the mouth guide can be disposed in the vicinity of the mouth of the living body.

Further, the area of the mouth guide opposing the face is wholly formed into the shape of a smooth recessed surface. The recessed portion is in communication with the expired gas passage, and hence the orally-expired gas flows to the expired gas passage without undergoing any resistance (Claim 1).

[0017]

Here, the horizontal shaft is formed integrally with the mouth guide and engaged with a hole formed in the support member. As a result, the number of components can be curtailed (Claim 2).

[0018]

The mouth guide is formed from a soft material, and hence the horizontal shaft can be readily inserted into the hole. Further, the horizontal shaft is inserted into the hole through clearance fitting. Therefore, appropriate resistance is afforded when the mouth guide is pivoted (Claim 3).

[0019]

The number of holes formed in the support member is two, and the number of horizontal shafts provided is two. The holes and the horizontal shafts are formed such that, when the horizontal shafts are engaged with the holes, neighborhoods of the holes of the support member and neighborhoods

of the horizontal shafts of the mouth guide press against each other in the axial direction of the horizontal shafts by means of resilience of the mouth guide and/or that of the support member. Therefore, appropriate resistance is afforded when the mouth guide is pivoted (Claim 4).

[0020]

The support member has a wall which protrudes downward therefrom exclusive of an area of the support member opposing the face; the protruding wall defines, in an area of the protruding wall opposing the face, a communication path remaining in communication with the expired gas passage, and the hole is formed in the protruding wall in a horizontal direction parallel to the face of the living body. Hence, the protruding wall brings the recessed portion of the mouth guide into smooth communication with the expired gas passage (Claim 5).

[0021]

The present invention also provides a carbon dioxide measurement sensor for measuring the concentration, partial pressure, or presence/absence of carbon dioxide in an expired gas of a living body, the sensor comprising: light-emitting means and light-receiving means, which are axially disposed so as to oppose each other; a support member for supporting the light-emitting means and the light-receiving means; an expired gas passage which is provided in the support member and enables the expired gas to cross the optical axis when the support member is attached to a location below nostrils of the living body; an oxygen supply tube for supplying oxygen; and a latch member for latching the oxygen supply tube on the support member, wherein prongs of the oxygen supply tube are of such a length that the prongs are not

inserted into nostrils of a living body while the oxygen supply tube is latched by the latch member, and the prongs are arranged such that the oxygen supplied from the prongs is not ejected directly into the nostrils of the living body (Claim 6).

[0022]

By means of such a configuration, the concentration, partial pressure, or presence/absence of carbon dioxide in the expired gas of the living body can be measured. Moreover, at the time of supply of oxygen, the oxygen supplied from the prongs of the oxygen supply tube is not ejected directly into the nostrils of the living body, thereby preventing occurrence of abrupt drying of the nostrils.

[0023]

The present invention is also characterized by providing a carbon dioxide measurement sensor for measuring the concentration, partial pressure, or presence/absence of carbon dioxide in an expired gas of a living body, the sensor comprising: light-emitting means and light-receiving means, which are axially disposed so as to oppose each other; a support member for supporting the light-emitting means and the light-receiving means; an expired gas passage which is provided in the support member and enables the expired gas to cross the optical axis when the support member is attached to a location below nostrils of the living body; and a latch member for latching an oxygen supply tube on the support member, wherein the latch member is configured such that, when the oxygen supply tube is latched by the latch member, oxygen supplied from prongs of the oxygen supply tube is not ejected directly into the nostrils (Claim 7).

[0024]

By means of such a configuration, the concentration, partial pressure, or presence/absence of carbon dioxide in the expired gas of the living body can be measured. In addition, at the time of supply of oxygen, the oxygen supply tube is latched by the latch member, and the oxygen supplied from the prongs of the oxygen supply tube is not ejected directly into the nostrils of the living body, thereby preventing occurrence of abrupt drying of the nostrils.

[0025]

The carbon dioxide measurement sensor is characterized by further including a horizontal shaft disposed at a position below the support member; and a mouth guide which is supported by the horizontal shaft and pivotable back and forth with reference to the mouth of the living body and whose area opposing the face of the living body is wholly formed into a smooth recess, wherein the recessed portion remains in communication with the expired gas passage (Claim 8).

By means of such a configuration, the mouth guide is pivoted about the horizontal shaft, whereby the position of the mouth guide can be adjusted along the geometry of the face. Hence, even when the geometry or size of the face varies from that corresponding to the current configuration, the mouth guide can be adjusted to the vicinity of the mouth.

[0026]

The carbon dioxide measurement sensor is characterized by further including a nasally-expired gas inlet member which is disposed on an upper portion of the support member and inserted at one end thereof to the nostrils for guiding the nasally-expired gas from the nostrils to the expired gas passage

and at the other end thereof to the expired gas passage; and in that a vent for bringing the inside of the expired gas inlet member into communication with the outside is formed in an area of the nasally-expired gas inlet member, the area being located in the vicinity of a node between the nasally-expired gas inlet member and the expired gas passage (Claim 9).

[0027]

By means of the foregoing configuration in which the orally-expired gas and the nasally-expired gas are guided to the expired gas passage, one end of the nasally-expired gas inlet member is inserted into the nostrils. Hence, the cross-sectional area of the expired gas passage cannot be made sufficiently large. However, the cross-sectional area of the expired gas passage of the mouth guide disposed at a position below the expired gas passage is large. Hence, superior escape of the gas from the expired gas passage is achieved. Therefore, the majority of the nasally-expired gas that has passed through the nasally-expired gas inlet member is guided into the expired gas passage.

In the case of oral breathing, a lot of gas leaks from a clearance between the mouth guide and the surface. As mentioned previously, the cross-sectional area of the expired gas passage for the nasally-expired gas inlet member cannot be made sufficiently large. However, when the orally-expired gas is guided to the expired gas passage, the gas remaining in the expired gas passage is discharged to the outside by way of the vent as well as the nasally-expired gas inlet member. Further, even when the nasally-expired gas inlet member is clogged with a nasal discharge, the gas in the expired gas passage is discharged to the outside by way of the vent.

Therefore, superior escape of the gas from the expired gas passage is achieved. Even when the amount of expired gas is small, an amount of orally-expired gas sufficient for measurement can be introduced into the expired gas passage.

[0028]

The nasally-expired gas inlet member is characterized by comprising a pair of tubes, and a merge section where passages of the pair of tubes merge at a portion of the merge section close to the support member and remain in communication with the expired gas passage, wherein the vent is formed in an exterior wall defining the merge section (Claim 10).

[0029]

By means of such a configuration, when the orally-expired gas is guided to the expired gas passage, the gas remaining in the expired gas passage is discharged to the outside by way of the pair of tubes and the vent. Even if the tubes have been clogged with a nasal discharge, the gas in the expired gas passage is discharged to the outside. Consequently, superior escape of the gas from the expired gas passage is achieved. Even when the amount of expired gas is small, an amount of orally-expired gas sufficient for measurement can be introduced into the expired gas passage.

[0030]

The vent is characterized by being provided in a location where discharge of a gas in the expired gas passage to the outside from the vent is not less likely to be affected by the living body when the carbon dioxide measurement sensor is attached to the living body (Claim 11).

[0031]

By means of such a configuration, when the orally-expired gas is guided to the expired gas passage, the gas remaining in the expired gas passage can be efficiently discharged to the outside while being less likely to be impeded by the living body. Even when the amount of expired gas is small, an amount of orally-expired gas sufficient for measurement can be introduced into the expired gas passage.

[0033]

The vent is characterized by being provided in a position where the vent does not oppose the living body when the carbon dioxide measurement sensor is attached to the living body (Claim 12).

[0033]

By means of such a configuration, when the orally-expired gas is guided to the expired gas passage, the gas remaining in the expired gas passage can be expired efficiently to the outside without being impeded by the living body. Thus, even when the amount of expired gas is small, an amount of orally-expired gas sufficient for measurement can be introduced into the expired gas passage.

[0034]

[Embodiments of the Invention]

Embodiments of the present invention will be described in detail hereunder by reference to the drawings.

[0035]

Fig. 1 shows a carbon gas measurement sensor 1 according to the present invention. In order to measure the concentration, partial pressure, or presence/absence of a carbon dioxide gas in an expired gas of a person 3

who is a living body, the carbon dioxide measurement sensor 1 comprises a light-emitting element 10 serving as light emission means, and a light-receiving element 11, which are arranged so as to oppose each other in an optical shaft; an airway case 12 serving as a support member for supporting the light-emitting element 10 and the light-receiving element 11; and an expired gas passage 13 (see Fig. 2) which enables the expired gas of the person 3 to pass through the optical shaft when the airway case 12 is attached to an area located below nostrils 31 of the person 3.

[0036]

The carbon dioxide gas measurement sensor 1 comprises a horizontal shaft 14 which is disposed on a protruding wall 19 extending toward a lower portion of the airway case 12 and extends parallel to the surface of the face of the person 3; a mouth guide 15 which can pivot back and forth about the horizontal shaft 14 to approach or depart from a mouth 32 of the person 3 with appropriate pivotal resistance; a lead wire 16a for transmitting an illumination signal from the unillustrated carbon dioxide measurement apparatus to the light-emitting element 10; and a lead wire 16b for transmitting a received-light signal from the light-receiving element 11 to the unillustrated carbon dioxide measurement apparatus.

[0037]

The respective constituent elements will now be described. The airway case 12 is formed from nonflexible resin. As shown in Fig. 2, the light-emitting element 10 and the light-receiving element 11 are hermetically sealed within the airway case 12 by means of defogging films 17, 17 whose mutually-opposing surfaces permit transmission of light and prevent fogging

which would otherwise be caused by the expired gas.

[0038]

The expired gas passage 13 is defined by interior walls 12a, 12b and the defogging films 17, 17, both being provided in the airway case.

[0039]

An optical filter (not shown) for permitting passage of only light having a wavelength to be absorbed by a carbon dioxide gas is disposed on the light-receiving element 11. In Fig. 2, reference numeral 18 designates a defogging film case.

[0040]

The light-emitting element 10 is equipped with the lead wire 16a, and the light-receiving element 11 is equipped with the lead wire 16b.

[0041]

As shown in Fig. 3, the expired gas passage 13 is connected to a flexible tube (nasal tube) 21. This flexible tube 21 is formed from silicon rubber or the like or from vinyl chloride, polypropylene, polyethylene, an elastomer, or the like.

[0042]

The flexible tube has a pair of insert sections 21a, 21b formed in the shape of a Y. When the insert sections 21a, 21b are inserted into the nostrils 31 of the person 3 (see Fig. 1), a nasally-expired gas is guided to the expired gas passage 13 by way of the flexible tube 21.

[0043]

The mouth guide 15 is attached to the part of the airway case 12 opposite the flexible tube 21 connected to the expired gas passage 13 such

that the gas expired from the mouth flows into the expired gas passage 13. The mouth guide 15 is formed from soft material into the shape of a tongue flap, and the width "b" of the mouth guide 15 is determined to an appropriate dimension; e.g., 20 mm or less in the embodiment.

[0044]

The width "b" is preferably sufficiently narrow that a suction tube 23 (see Fig. 1) can be inserted into the mouth while the person 3 is wearing the carbon dioxide gas measurement sensor 1 and sufficiently wide that an expired gas from the mouth can be sufficiently received. To this end, the width "b" of the mouth guide 15 is preferably set to 5 to 20 mm or thereabouts.

[0045]

In order to minimize escape of the expired gas, a sidewall 22 (see Fig. 4) is provided on both sides of the mouth guide 15 such that a portion of the sidewall 22 facing the mouth 32 becomes concave.

[0046]

As shown in Fig. 4, the mouth guide 15 is configured so as to be pivotable about the horizontal shaft 14 latched by the protruding wall 19 extending downward from the airway case 12 in a direction X in which the mouth guide 15 approaches and departs from the mouth 32 of the person 3 (see Fig. 1); that is, in the forward and backward directions. The mouth guide 15 is attached to the sensor 1 such that the direction designated by arrow F is directed toward the face.

[0047]

Material of the mouth guide 15 can be selected, as required, from soft materials such as vinyl chloride, polypropylene, polyethylene, silicon rubber, or

an elastomer.

[0048]

As shown in Figs. 3 and 4, the protruding wall 19 is constituted of walls 19a, 19b, and 19c which extend from the lower part of the airway case 12 in three directions; i.e. the four cardinal directions other than a direction toward the face of the person 3. The walls are continuous without clearances. The walls 19a, 19b have coaxial holes 20, 20 which are formed horizontally parallel to the face of the person 3.

[0049]

As shown in Fig. 3, the horizontal shaft 14 is formed integrally from the mouth guide 15 and made up of mushroom-shaped shafts 14a, 14b having the same dimensions. The outside diameters of small-diameter sections of the respective shafts 14a, 14b are determined so as to be slightly larger than the inner diameters of holes 20, 20 of the walls 19a, 19b before the shafts 14a, 14b are assembled into the holes 20, 20. The shafts 14a, 14b are inserted into the holes 20, 20 by means of clearance fitting. Therefore, the mouth guide 15 can pivot about the holes 20, 20 (shafts 14a, 14b) with appropriate resistance.

[0050]

A slot may be formed in the mushroom-shaped top of the shaft 14a, and in that of the shaft 14b. In such a case, the shafts 14a, 14b can be inserted into the holes 20, 20 more easily.

[0051]

As shown in Fig. 4, the wall 19c of the protruding wall 19 is configured so as to cover an end section 15a proximate to the horizontal shaft 14 of the

mouth guide 15 even when the mouth guide 15 is situated a position close to the face of the person 3 (i.e., a position indicated by broken lines), thereby lessening circulation resistance against the expired gas flowing from the mouth into the expired gas passage 13.

[0052]

As shown in Fig. 1, the mouth guide 15 is arranged around the mouth of the person 3, whereby the expired gas is led to the expired gas passage 13 along the mouth guide 15 without fail.

[0053]

The mouth guide 15 is pivotable about the horizontal shaft 14 back and forth with appropriate resistance. Therefore, even when the shape and size of the face of the person 3 varies from that corresponding to the current configuration the mouth guide 15 is subjected to positional adjustment along the contour of the face and can be caused to approach the mouth 32 of the person 3.

[0054]

Therefore, the majority of the expired gas of the person 3 can be led to the expired gas passage 13 of the airway case 12 reliably without any escape from the mouth guide 15. As a result, the concentration of carbon dioxide in the orally-expired gas can be measured reliably and without fail.

[0055]

Since the horizontal shaft 14 is formed integrally with the mouth guide 15, the mouth guide can be manufactured inexpensively with the number of parts and man-hours being curbed.

[0056]

In the present embodiment, the shafts 14a, 14b are inserted into the holes 20, 20 through clearance fitting with a view toward imparting resistance to the pivotal movement of the mouth guide 15. Alternatively, the dimension "c" of the mouth guide 15 shown in Fig. 3 (i.e., a distance between bases of the shafts 14a, 14b) may be made greater than the inner distance between the walls 19a, 19b before the shafts 14a, 14b are assembled into the holes 20, 20. In such a case, repulsion develops in an area where the mouth guide 15 horizontally remains in contact with the walls 19a, 19b in an assembled state, so that appropriate resistance can be imparted to the pivotal movement of the mouth guide 15.

[0057]

In this case, the small diameters of the shafts 14a, 14b may be made smaller than the internal diameters of the holes 20, 20, and they may be respectively fitted together through clearance fitting. As a result, assembly of the carbon dioxide measurement sensor becomes simple.

[0058]

The dimension "c" of the mouth guide 15 may be made greater than the internal distance between the walls 19a and 19b, and the shafts 14a, 14b may be formed cylindrically and assembled to the respective holes 20, 20 through clearance fitting. In such a case, the assembly of the carbon dioxide measurement sensor becomes much simpler.

[0059]

When the small diameters of the shafts 14a, 14b are made smaller than the inner diameters of the holes 20, 20 and they are assembled together through clearance fitting, soft material is preferable as a material of the mouth

guide 15, in consideration of a case where the mouth guide 15 comes into contact with the living body. However, when an outer periphery of the mouth guide 15 is formed into a shape which does not inflict any pain on the living body when having come into contact with the living body, unsoft resin or the like may also be employed.

[0060]

In any of the foregoing embodiments, the horizontal shaft 14 is formed integrally with the mouth guide 15, and the holes 20 are formed in the protruding wall 19 of the airway case 12. However, the horizontal shaft 14 may be formed integrally with the protruding wall 19, and the holes 20 may be formed in the mouth guide 15.

[0061]

In this case, so long as the mouth guide 15 is formed from soft material, the horizontal shaft 14 made of unsoft resin can be readily inserted into the holes 20.

[0062]

In any one of the embodiments, the protruding wall 19 is constituted of the three walls 19a, 19b, and 19c. However, the only requirement is that walls are provided except at a position where the wall would oppose the face of the person 3. For instance, a horizontal cross-sectional profile of the protruding wall 19 may be semi-circular or semi-oval.

[0063]

According to the invention, the carbon dioxide measurement sensor 1 can also be rendered able to supply oxygen by means of providing the sensor with the oxygen supply tube (which may also be general purpose use) through

use of a mount hook 33 serving as a latching member.

[0064]

As shown in Fig. 5, the mount hook 33 is provided on the back of the airway case 12 of the carbon dioxide measurement sensor 1 (i.e., the side surface of the airway case 12 opposite the side surface facing the face when the sensor is attached to the living body), to thereby enable attachment of an oxygen supply tube 34.

[0065]

As shown in Fig. 6, the mount hook 33 has a tubular hook section 33a having an opening section 33c so as to enable attachment of the oxygen supply tube 34. A tube portion of the oxygen supply tube located between two prongs 35 is attached to the mount hook 33 by way of the opening section 33c. In order to prevent deformation of the prongs 35, which would otherwise be caused by application of external force, the width of the tubular hook section 33a is preferably made equal to the distance between the two prongs 35. The tubular hook section 33a can be applied to the oxygen supply tube 34 regardless of the diameter thereof, through use of an elastic material. Such a mount hook 33 is bonded to the back of the airway case 12.

Alternatively, as shown in Fig. 7B, the airway case 12 and the mount hook 33 may be formed integrally.

[0066]

Fig. 7A is a view showing a state in which the mount hook 33 is used while the oxygen supply tube 34 is attached to the hook.

Reference numeral 34a designates an oxygen supply port of the oxygen supply tube 34. Reference numeral 16c designates a connector for

electrically connecting an electric current employed for activating the light-emitting element 10 and the signal detected by the light-receiving element 11 to the measurement sensor.

At this time, the prongs 35 are made not to be inserted into the nostrils and arranged such that the oxygen supplied from the prongs 35 is not ejected directly into the nostrils. As a result, abrupt drying of the nostrils can be prevented.

In the embodiment shown in Fig. 7A, in order to realize such an arrangement, the mount hook 33 is disposed such that the prongs 35 are arranged on an upper surface of the airway case 12. In this case, the oxygen supplied from the prongs 35 is not ejected directly into the nostrils. The oxygen is aspirated by the nostrils after having come into collision with the skin located below the nose and wafted.

[0067]

Fig. 8A shows another embodiment featuring a different arrangement of the mount hook 33. As shown in Fig. 8A, the mount hook 33 is provided such that the prongs 35 are aligned in line with the back of the airway case 12. In this case, the air supplied from the prongs 35 is directed parallel to the back of the airway case 12 toward the flexible tube 21 and wafted and aspirated by the nostrils.

As shown in Fig. 8B, the mount hook 33 may be formed integrally with the airway case 12.

[0068]

Fig. 9A shows still another example featuring a different layout of the mount hook 33. As shown in Fig. 9A, the mount hook 33 is provided such

that the prongs 33 are aligned with the bottom surface of the airway case 12. Even in this case, as in the case shown in Fig. 7A, the oxygen supplied by way of the prongs 35 is ejected directly into the mouth and aspirated.

As shown in Fig. 9B, the mount hook 33 may be formed integrally with the airway case 12.

[0069]

Fig. 10A shows yet another example featuring a different layout of the mount hook 33. As shown in Fig. 10A, the mount hook 33 is disposed on the back of the airway case 12 such that the extremities of the prongs 35 are directed toward the back of the airway case 12 by means of rendering a handle 33b of the mount hook sufficiently long. By means of adoption of such a configuration, the oxygen supply tube 34 is attached to the tubular hook section 33a, and the oxygen can be supplied to the face. Once having come into collision with the airway case 12 and wafted, the oxygen supplied by way of the prongs 35 can be aspirated by the nostrils and the mouth. The orientation in which the extremities of the prongs 35 are directed toward the face can be adjusted by means of the angle at which the oxygen supply tube 34 is attached to the tubular hook 33a of the mount hook 33.

As shown in Fig. 10B, the mount hook 33 may be integrally formed with the airway case 12.

[0070]

Further, the mount hook 33 may be attached to another side surface of the airway case 12, and the mount hook 33 may latch the prongs 35.

Moreover, according to the invention, with a view toward accurate measurement of concentration, partial pressure, or presence/absence of

carbon dioxide even when the amount of an expired gas is small, the carbon dioxide measurement sensor can have a vent to be used for immediately discharging a gas remaining in the expired gas passage at the time of oral breathing.

[0071]

Another embodiment shown in Figs. 11 through 14 differs from that shown in Figs. 1 through 4 only in terms of ventilation. Therefore, like elements are assigned like reference numerals, and their repeated explanations are omitted.

[0072]

Fig. 11 shows a plan view of a carbon dioxide measurement sensor 51 having a vent according to the present invention. Fig. 12 shows a cross-sectional view taken along line C-C shown in Fig. 11, and Fig. 13 is a view showing flow of an orally-expired gas when the person 3 wears the carbon dioxide measurement sensor 51.

[0073]

In an upper portion of the airway case 12 acting as a support member, the pair of insert sections 21a, 21b of the flexible tube 21, the tube having a small passage cross-sectional area, to be inserted into the nostrils 31 are extended at non-insert sections thereof. The insert sections 21a, 21a merge with each other in the vicinity of the expired gas passage 13, thereby defining a merge section 40 having a large passage cross-sectional area. The merge section 40 is in close proximity to and in communication with the expired gas passage 13 having a much larger cross-sectional area. The nasally-expired gas inlet member 42 is constituted of the soft tube 21 and the merge section

40. In order to immediately discharge the air remaining in the expired gas passage 13 simultaneously when breath is discharged from the mouth, a vent 41 is formed for bringing the inside of the merge section 40 into communication with the outside.

[0074]

As mentioned previously, in order to immediately discharge to the outside the gas remaining in the expired gas passage 13 when breath is discharged from the mouth, the vent 41 is disposed downstream of the expired gas passage 13 with respect to the direction of flow of the orally-expired gas. Further, the location and shape of the vent 41 are determined so as not to oppose the flow of the nasally-expired gas, in order to block leakage of the nasally-expired gas to the outside by way of the vent 41, and so that the face does not hinder circulation of the gas passing through the vent 41.

As shown in Figs. 11 through 13, the vent 41 is circular (e.g., having a diameter of 2 mm) and formed in an exterior wall of the merge section 40 so as to situate at the center of the exterior wall facing away from the face. In Fig. 11, the carbon dioxide measurement sensor 51 is attached such that the direction of arrow F faces the face.

[0075]

Operation of the carbon dioxide measurement sensor of such a configuration will now be described.

As indicated by the arrow in Fig. 13, when breath is discharged from the mouth 32, the orally-expired gas is guided to the expired gas passage 13 by way of the mouth guide 15. The gas remaining in the expired gas passage 13 is pushed to the merge section 40. The thus-pushed gas flows to the

outside by way of the vent 41 and simultaneously enters the nostrils 31 by way of the soft tube 21, subsequently flowing outside. Since the soft tube 21 is elongated and has a small passage cross-sectional area, circulation resistance against the gas is large. Moreover, the vent 41 is provided in the merge section 40 adjacent to the expired gas passage 13. Consequently, the gas is likely to flow outside from the vent 41.

[0076]

Even when the soft tube 21 has been clogged with a nasal discharge, the gas can flow outside from the vent 41 as a result of inflow of the orally-expired gas to the expired gas passage 13.

[0077]

As mentioned above, since the carbon dioxide measurement sensor has the vent 41, excellent escape of the gas from the inside of the expired gas passage 13 is achieved. Therefore, when breath is discharged from the mouth, the gas remaining in the expired gas passage 13 is discharged to the outside, and the orally-discharged gas immediately flows into the expired gas passage 13. Consequently, even when the amount of expired gas is small, the concentration, partial pressure, or presence/absence of carbon dioxide in the orally-expired gas can be measured accurately.

[0078]

Next will be described an experiment in which the concentration of carbon dioxide in the orally-expired gas is measured and evaluated through use of the carbon dioxide measurement sensor having the vent and the carbon dioxide measurement sensor not having any vent.

[0079]

The measurement was evaluated by means of measuring the concentration of carbon dioxide through use of the carbon dioxide measurement sensor 51 having the vent 41, the sensor being shown in Figs. 11 through 13, and the carbon dioxide measurement sensor 1 not having the vent 41, and by means of comparing the results of measurement. Measurement was performed as described below.

A model for a human face and a nostril was used. As shown in Fig. 13, the sensor was attached to the model. The amount of gas to be measured corresponding to weak breath was delivered by a delivery pump for a given period of time corresponding to a period of time during which an ordinary person takes a single breath, to thereby discharge the gas to the mouth. Subsequently, the amount of gas corresponding to weak breath was sucked by means of a vacuum pump in place of the delivery pump for a given period of time corresponding to a period of time during which the ordinary person discharges a single breath. These operations were performed alternately. A gas—whose concentration is close to the concentration of carbon dioxide in an expired gas of the human attained by mixing carbon dioxide in air—was used as the gas to be measured.

[0080]

Measurement results are shown in Fig. 14. A solid line shows the results obtained by the sensor having the vent 41, whereas broken lines designate the results obtained by the sensor not having the vent 41.

As can be seen from Fig. 14, when the vent hole 41 is formed, the concentration of carbon dioxide has risen and become saturated immediately after initiation of ejection of the gas to be measured. This shows immediate

flow of the gas to be measured into the expired gas passage 13, and the effect of the vent 41 is exhibited well.

In contrast, when the vent is not formed, the concentration of carbon dioxide does not rise soon and rises with a lag and gradually increases even when the gas to be measured has been expired. The increase continues until initiation of inspiration. Subsequently, the concentration of carbon dioxide does not saturate and gradually decreases. This shows that flow of the gas to be measured into the expired gas passage 13 is performed gradually.

[0081]

As mentioned above, even when the amount of expired gas is small, the concentration of carbon dioxide in the expired gas can be measured accurately by means of the vent 41.

[0082]

When the vent 41 is formed, the concentration of carbon dioxide has decreased sharply after initiation of sucking operation. This shows that an external gas flows into the expired gas passage 13 by way of the vent 41 and that the gas to be measured has been immediately discharged to the outside.

[0083]

The embodiment of the invention shown in Figs. 11 through 14 has been described thus far. However, the present invention is susceptible to various modifications such as those shown below.

[0084]

The nasally-expired gas inlet member 42 has been described as being constituted of a pair of tubes (i.e., the pair of insert sections 21a, 21b of the soft tube 21 to be inserted into the nostrils 31) and the merge section 40

merged with the respective ends of the tube. However, the nasally-expired gas inlet member may be constituted of a single tube. In this case, a vent is formed in an area of the tube, where the area is in close proximity to a node between the tube and the expired gas passage 13.

[0085]

The vent 41 is given a circular shape having a diameter of 2 mm and is formed in the exterior wall of the merge section 40 so as to be located in the center of the portion thereof facing away from the living body. The vent 41 may assume any shape or location, so long as the above-described requirements are satisfied. Fig. 15 shows a modification of the location where the vent is to be formed. Fig. 15 shows the neighborhood of the merge section 40 shown in Fig. 13 in an enlarged manner. As illustrated by a phantom line, the vent can be formed in any one of locations 41a, 41b, 41c, and 41d. In a position where the vent 41c or the like may be closed by the living body, an opening of the vent 41c may be set to an oval shape in which longitudinal portions of the oval become parallel to the face. Although the diameter of the vent 41 is taken as 2 mm, the diameter can be set so as to satisfy the foregoing requirements by reference to the structure, such as the soft tube 21, the merge section 40, and the expired gas passage 13.

[0086]

[Advantages of the Invention]

As has been described above, according to the invention, the mouth guide is pivoted about the horizontal shaft, whereby the position of the mouth guide can be adjusted along the geometry of the face. Even when the geometry or size of the face of the living body varies drastically from that

corresponding to the current configuration, the mouth guide can be disposed in the vicinity of the mouth of the living body.

Further, the area of the mouth guide opposing the face is wholly formed into the shape of a smooth recessed surface. The recessed portion is in communication with the expired gas passage, and hence the orally-expired gas flows to the expired gas passage without undergoing any resistance.

Accordingly, the majority of the orally-expired gas can be guided to the expired gas passage reliably without any escape from the mouth guide, and hence the concentration, partial pressure, or presence/absence of carbon dioxide in the orally-expired gas can be measured accurately (claim 1).

[0087]

Since the horizontal shaft is formed integrally with the mouth guide and engaged with the hole formed in the support member, the carbon dioxide measurement sensor can be manufactured inexpensively while the number of components and man-hours are minimized (claim 2).

[0088]

Since the mouth guide is formed from a soft material, the horizontal shaft formed integrally with the mouth guide can be readily inserted thereinto. Further, the horizontal shaft is inserted into the hole through clearance fitting, and hence appropriate resistance can be imparted to pivotal movement of the mouth guide. Therefore, the mouth guide can be readily set along the mouth of the living body. Moreover, even when the mouth guide has come into contact with the face, pain experienced by the person can be minimized by the softness and pivotal movement of the mouth guide (claim 3).

[0089]

The mouth guide and the support member are formed such that, when the two horizontal shafts are engaged with the holes of the support member, the neighborhoods of the holes of the support member and the neighborhood of the horizontal shafts of the mouth guide press against each other in the axial direction of the horizontal shafts by means of resilience of the mouth guide and/or that of the support member. Appropriate resistance can be imparted to pivotal movement of the mouth guide. Therefore, the mouth guide can be readily set along the mouth of the living body. Moreover, even when the mouth guide has come into contact with the face, pain experienced by the person can be minimized by means of pivotal movement of the mouth guide (claim 4).

[0090]

The support member has a wall which protrudes downward therefrom exclusive of the area of the support member opposing the face. The protruding wall defines, in the portion of the protruding wall opposing the face, a communication path which is in communication with the expired gas passage. A hole is formed in the protruding wall in a horizontal direction parallel with the face of the living body. The shaft formed integrally with the mouth guide is inserted into the hole. As a result, the protruding wall brings the recessed portion of the mouth guide into smooth communication with the expired gas passage. Consequently, the orally-expired gas reaches the expired gas passage without undergoing resistance (Claim 5).

[0091]

Alternatively, the prongs of the oxygen supply tube are of such a length that the prongs are not inserted into the nostrils of the living body. The

prongs are arranged so that the oxygen supplied from the prongs is not ejected directly into the nostrils of the living body. Hence, the concentration, partial pressure, or presence/absence of carbon dioxide in the expired gas of the living body can be measured. Moreover, at the time of supply of oxygen, the oxygen supplied from the prongs of the oxygen supply tube is not ejected directly into the nostrils of the living body, thereby preventing occurrence of abrupt drying of the nostrils (claim 6).

[0092]

Alternatively, the latch member is configured such that the oxygen supplied from the prongs of the oxygen supply tube is not ejected directly into the nostrils of the living body when the oxygen supply tube is latched by the latch member. Therefore, the concentration, partial pressure, or presence/absence of carbon dioxide in the expired gas of the living body can be measured. In addition, at the time of supply of oxygen, the oxygen supply tube is latched by the latch member, and the oxygen supplied from the prongs of the oxygen supply tube is not ejected directly into the nostrils of the living body, thereby preventing occurrence of abrupt drying of the nostrils (claim 7).

[0093]

Moreover, the carbon dioxide measurement sensor is configured to comprise the horizontal shaft arranged on the lower portion of the support member, and the mouth guide which is supported by the horizontal shaft and pivotable back and forth with reference to the mouth of the living body and whose area opposing the face of the living body is wholly formed into a smooth recess, wherein the recessed portion remains in communication with the expired gas passage. Further, the mouth guide is pivoted about the

horizontal shaft, whereby the position of the mouth guide can be adjusted along the geometry of the face. Hence, even when a change has arisen in the geometry or size of the face, the mouth guide can be adjusted to the vicinity of the mouth (claim 8).

[0094]

In addition, the carbon dioxide measurement sensor has a nasally-expired gas inlet member which is disposed on an upper portion of the support member and inserted at one end thereof to the nostrils for guiding the nasally-expired gas from the nostrils to the expired gas passage and at the other end thereof to the expired gas passage. A vent for bringing the inside of the expired gas inlet member into communication with the outside is formed in the area of the nasally-expired gas inlet member, the area being located in the vicinity of the node between the nasally-expired gas inlet member and the expired gas passage. Therefore, when the orally-expired gas is guided to the expired gas passage, the gas remaining in the expired gas passage is discharged to the outside by way of the vent as well as by way of the nasally-expired gas inlet member. Even when the nasally-expired gas inlet member is clogged with a nasal discharge, the gas in the expired gas passage is discharged to the outside by way of the vent. Consequently, superior escape of the gas from the expired gas passage is achieved. Even when the amount of expired gas is small, an amount of gas sufficient for measurement can be introduced into the expired gas passage. The concentration, partial pressure, or presence/absence of carbon dioxide in the expired gas of the living body can be measured (claim 9).

[0095]

The nasally-expired gas inlet member is constituted of a pair of tubes; and a merge section where passages of the pair of tubes merge at a portion of the merge section close to the support member and remain in communication with the expired gas passage. The vent is formed in the exterior wall defining the merge section. Hence, when the orally-expired gas is guided to the expired gas passage, the gas remaining in the expired gas passage is discharged to the outside by way of the pair of tubes and the vent. Even if the tubes have been clogged with a nasal discharge, the gas in the expired gas passage is discharged to the outside. Consequently, superior escape of the gas from the expired gas passage is achieved. Even when the amount of expired gas is small, the amount of orally-expired gas sufficient for measurement can be introduced into the expired gas passage (claim 10).

[0096]

Further, the vent is formed at such a position where, when the carbon dioxide measurement sensor is attached to the living body, discharge of the gas in the expired gas passage to the outside by way of the vent is not affected by the living body. Hence, when the orally-expired gas is guided to the expired gas passage, the gas remaining in the expired gas passage can be efficiently discharged to the outside while being less likely to be impeded by the living body. Even when the amount of expired gas is small, an amount of orally-expired gas sufficient for measurement can be introduced into the expired gas passage (claim 11).

[0097]

In addition, the vent is formed in the position where the vent does not oppose the living body when the carbon dioxide measurement sensor is

attached to the living body. Therefore, when the orally-expired gas is guided to the expired gas passage, the gas remaining in the expired gas passage can be expired efficiently to the outside without being impeded by the living body. Thus, even when the amount of expired gas is small, an amount of orally-expired gas sufficient for measurement can be introduced into the expired gas passage (claim 12).

[Brief Description of the Drawings]

Fig. 1 is a perspective view showing a carbon dioxide sensor according to the invention when the sensor is attached to a person;

Fig. 2 is a cross-sectional view showing an airway case;

Fig. 3 is a cross-sectional view of the carbon dioxide measurement sensor taken along line A-A shown in Fig. 2;

Fig. 4 is a view of the carbon dioxide measurement sensor when viewed in the direction of arrow B shown in Fig. 3;

Fig. 5 is a perspective view of a modification of the present invention when the modified carbon dioxide measurement sensor is attached to the person;

Fig. 6 is a fragmentary perspective view showing a modification of the invention where a mount hook is formed separately;

Fig. 7 shows a modification of the present invention, wherein Fig. 7A is a perspective view showing the carbon dioxide measurement sensor in an attached state and Fig. 7B is a fragmentary perspective view showing the carbon dioxide measurement sensor when the mount hook is formed integrally;

Fig. 8 shows another modification of the present invention, wherein Fig. 8A is a perspective view showing the carbon dioxide measurement sensor

in an attached state and Fig. 8B is a fragmentary perspective view showing the carbon dioxide measurement sensor when the mount hook is formed integrally;

Fig. 9 shows yet another modification of the present invention, wherein Fig. 9A is a perspective view showing the carbon dioxide measurement sensor in an attached state and Fig. 9B is a fragmentary perspective view showing the carbon dioxide measurement sensor when the mount hook is formed integrally;

Fig. 10 shows yet another modification of the present invention, wherein Fig. 10A is a perspective view showing the carbon dioxide measurement sensor in an attached state and Fig. 10B is a fragmentary perspective view showing the carbon dioxide measurement sensor when the mount hook is formed integrally;

Fig. 11 is a plan view showing another embodiment of the present invention;

Fig. 12 is a cross-sectional view of the carbon dioxide measurement sensor taken along line C-C shown in Fig. 11;

Fig. 13 is a view showing flow of an orally-expired gas when the carbon dioxide measurement sensor of the other embodiment is attached to the person;

Fig. 14 shows results pertaining to measurement of concentration of carbon dioxide in an orally-expired gas through use of the embodiment, wherein a solid line shows the results obtained by the sensor having a vent and broken lines show the results obtained by the sensor not having any vent;

Fig. 15 is a view showing a modification of a location where the vent is to be formed;

Fig. 16 is a view showing a conventional carbon dioxide measurement sensor; and

Fig. 17 is a view showing another conventional carbon dioxide measurement sensor.

[Descriptions of the Reference Numerals]

1, 51 CARBON DIOXIDE MEASUREMENT SENSOR

3 PERSON (LIVING)

10 LIGHT-EMITTING ELEMENT (LIGHT-EMITTING MEANS)

11 LIGHT-RECEIVING ELEMENT (LIGHT-RECEIVING MEANS)

12 AIRWAY CASE (SUPPORT MEMBER)

12a, 12b INTERIOR WALLS

13 EXPIRED GAS PASSAGE

14 HORIZONTAL SHAFT

14a, 14b MUSHROOM-SHAPED SHAFTS

15 MOUTH GUIDE

16a, 16b LEAD WIRES

17 DEFOGGING FILM

18 DEFOGGING FILM CASE

19 PROTRUDING SECTION

19a, 19b, 19c WALLS

20 HOLE

21 SOFT TUBE

21a, 21b INSERT SECTIONS

22 SIDEWALL

23 SUCTION TUBE

31 NOSTRILS

32 MOUTH

33 MOUNT HOOK (LATCH MEMBER)

40 MERGE SECTION

41 VENT

42 NASALLY-EXPIRED GAS INLET MEMBER

101 AIRWAY ADAPTER

101a ONE END

101b THE OTHER END

101c WINDOW SECTION

101d WINDOW SECTION

102 SENSOR MAIN BODY

103 LIGHT-EMITTING ELEMENT

104 OPTICAL FILTER

105 LIGHT-RECEIVING ELEMENT

106 LEAD WIRE

107 MONITOR MAIN BODY

110 EXPIRED GAS COLLECTOR

111 NASAL CANULA

112 JOINT SYSTEM

113 MOUTH GUIDE

114 ORALLY-EXPIRED GAS COLLECTING MEMBER

[Designation of the Document] Abstract

[Abstract]

[Object]

To provide a carbon dioxide gas measurement sensor which can efficiently send an orally-expired gas to an expired gas passage located in an upper section of a mouth guide and adjust the position of the mouth guide in accordance with the geometry or size of the face and which enables inexpensive manufacture of the sensor while minimizing the number of components and man-hours.

[How to Achieve the Object]

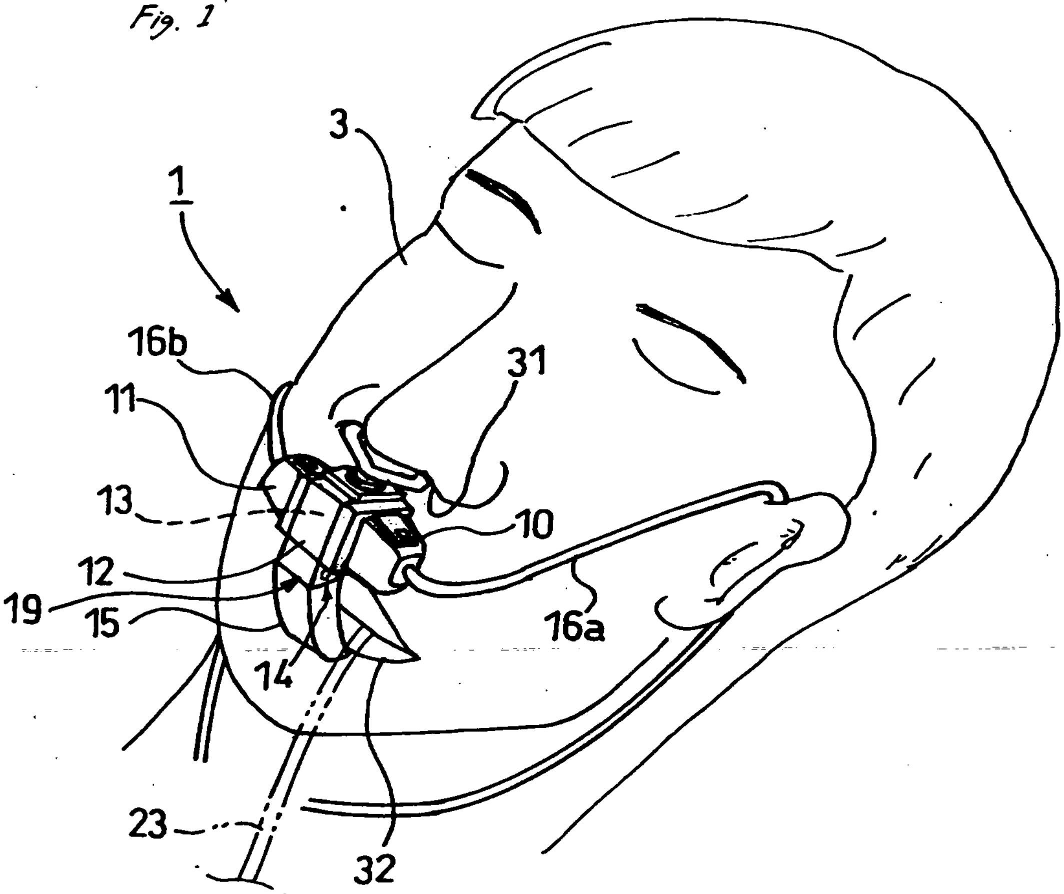
A carbon dioxide measurement sensor 1 has a light-emitting element 10 and a light-receiving element 11, which are disposed so as to axially oppose each other; an airway case 12 for supporting the light-emitting element 10 and the light-receiving element 11; an expired gas passage 13 which is provided in the airway case 12 and enables an expired gas to cross the optical axis when the airway case 12 is attached to a position located below nostrils 31 of a person 3; a horizontal shaft 14 located at a position below the airway case 12; and a mouth guide 15 which is supported by the horizontal shaft 14 and pivotable back and forth with reference to the mouth of the person 3, wherein a portion of the mouth guide 15 opposing the face of the person 3 is wholly formed into a smooth recess, and the recessed portion is in communication with an expired gas passage 13.

[Representative Drawing] Fig. 1

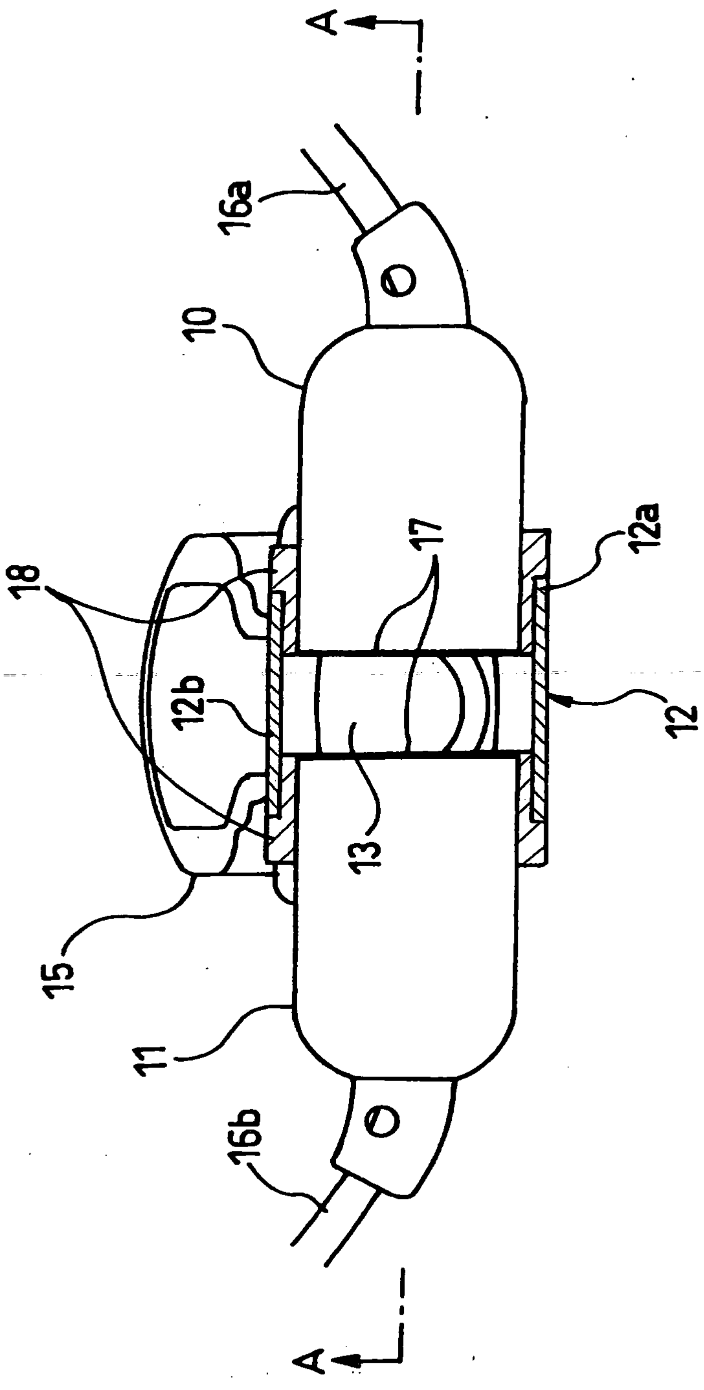
【書類名】　図面
Designation of Document　Drawings

【図１】

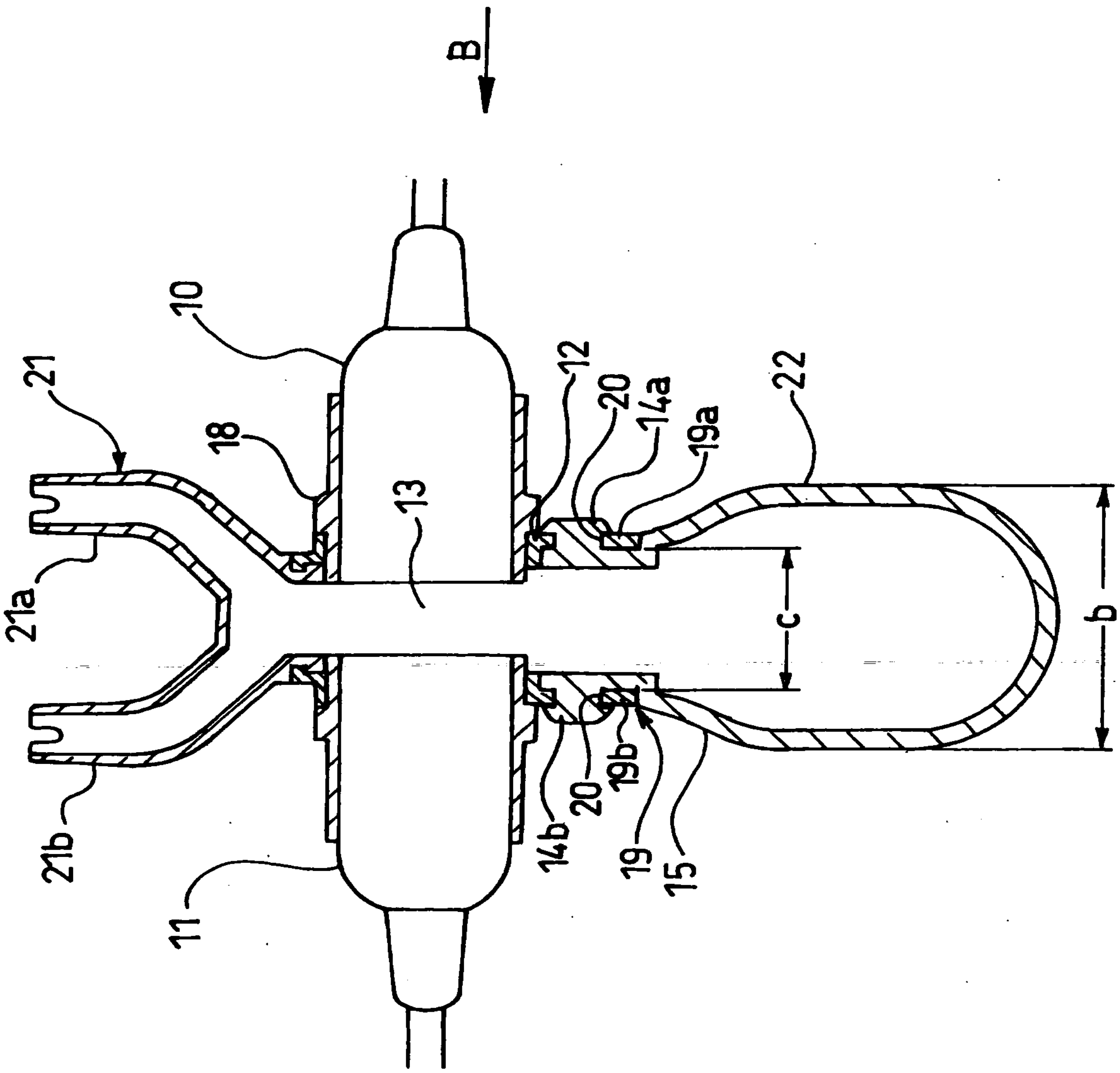
Fig. 1



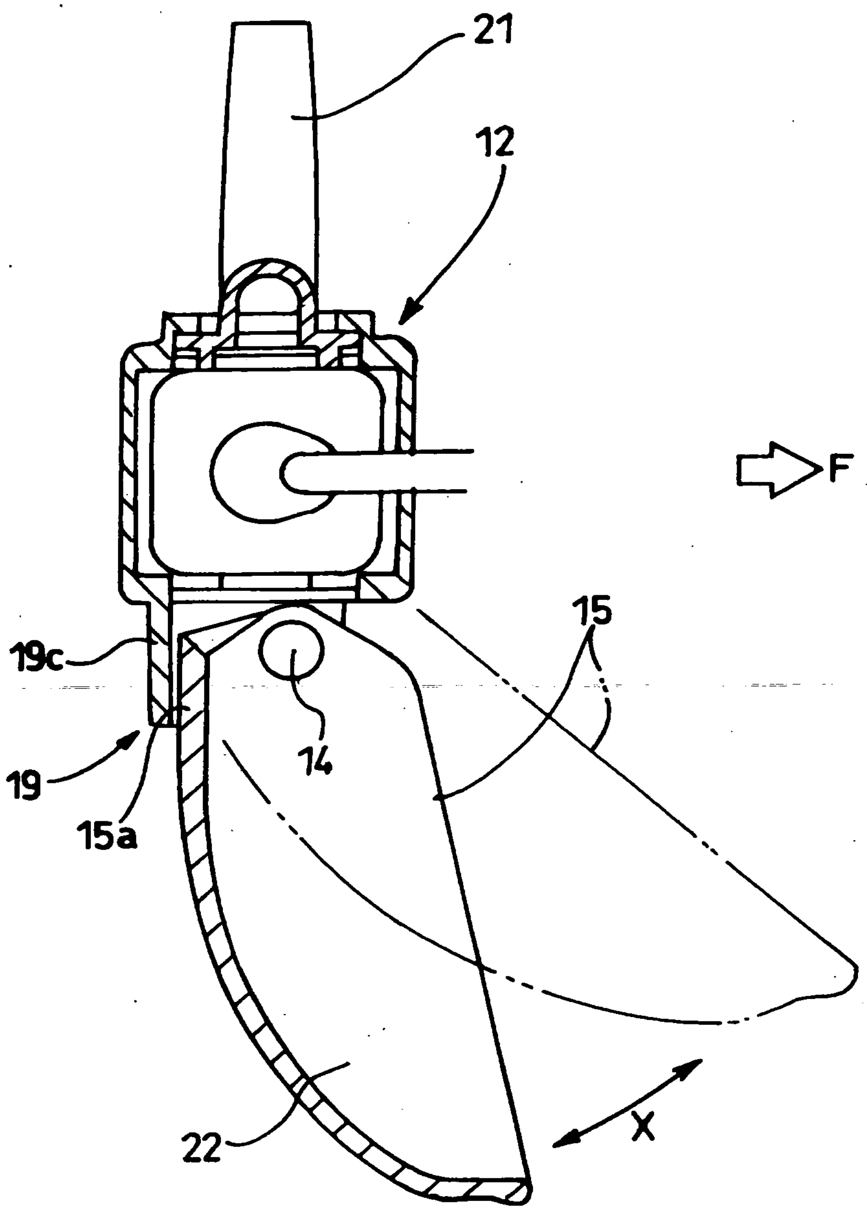
【図２】 Fig. 2



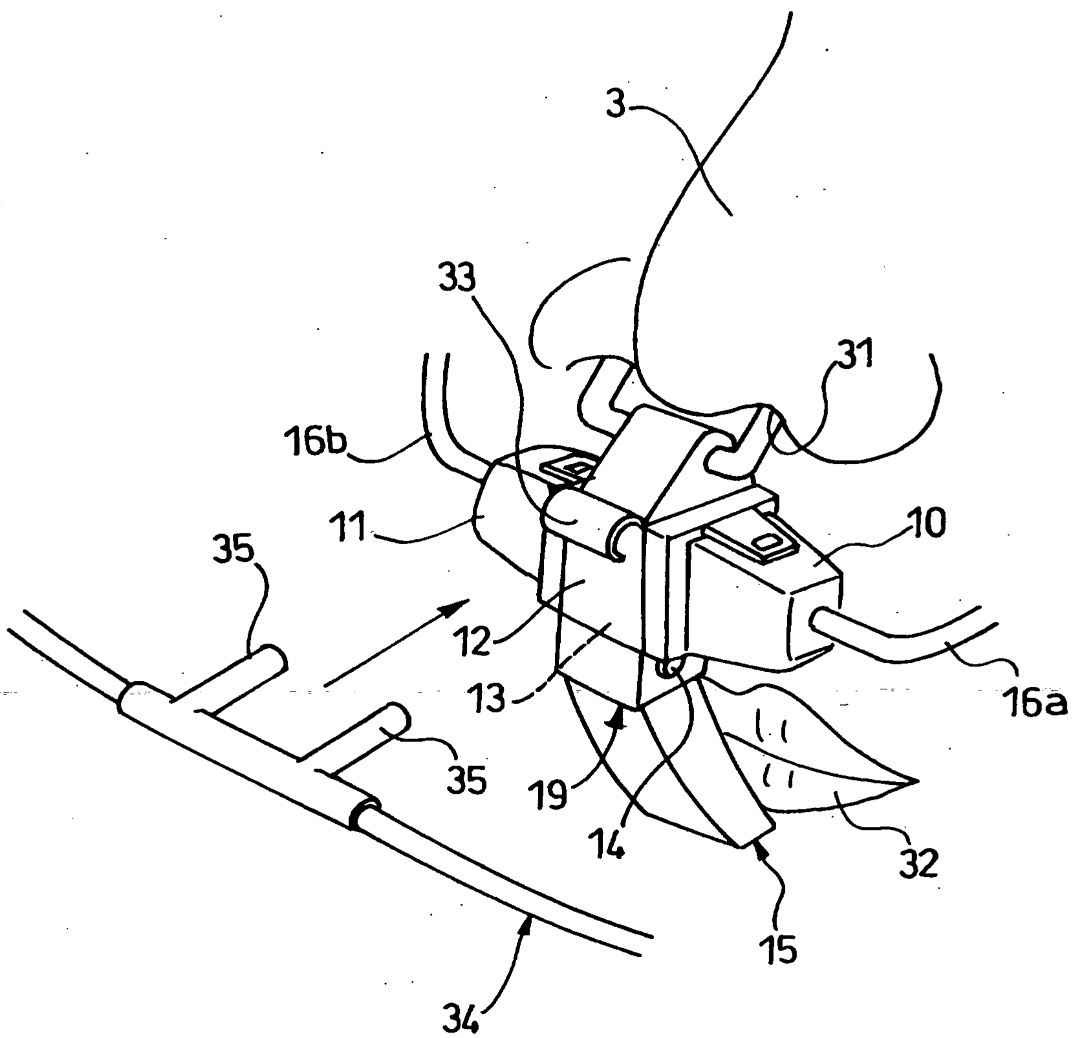
【図３】　Fig. 3



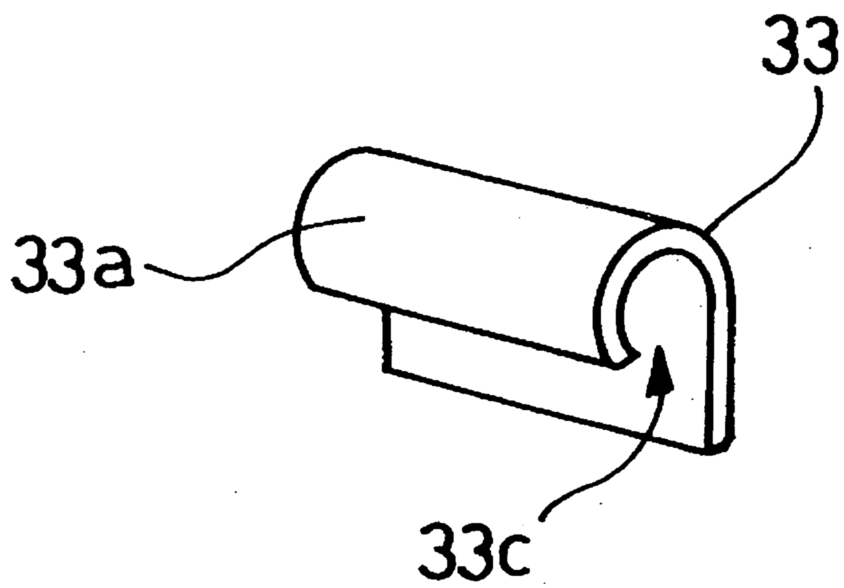
【図４】　Fig. 4



【図５】 Fig. 5

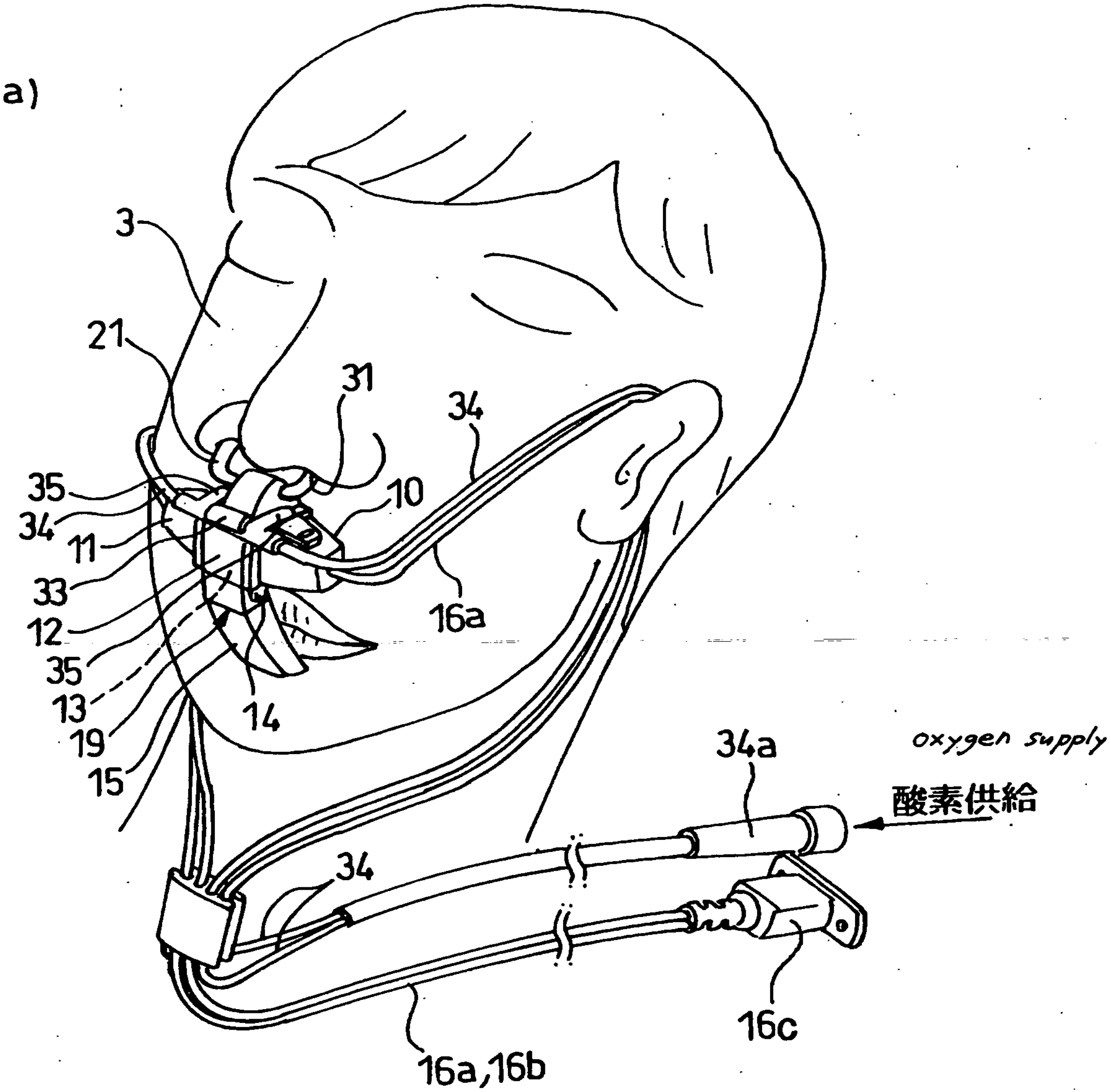


【図６】 Fig. 6

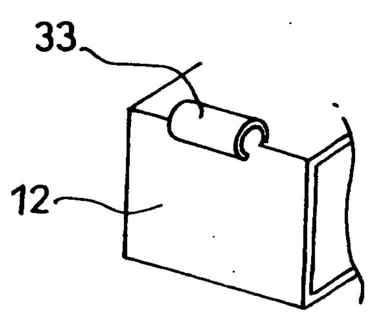


【図７】 *Fig. 7*

(a)

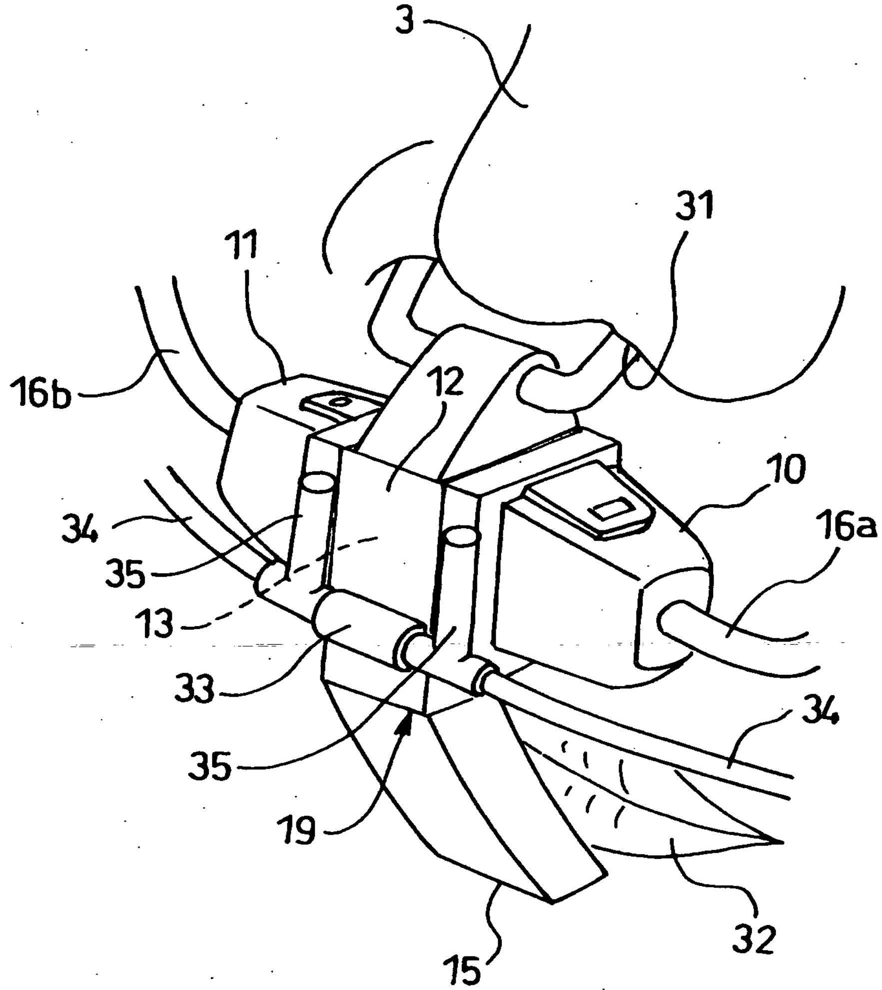

3
21
31
34
35
34
11
10
33
12
16a
35
13
14
19
15
34a
oxygen supply
酸素供給
34
16c
16a,16b

(b)

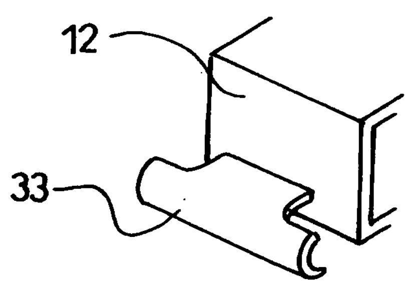

33
12

【図８】 *Fig. 8*

(a)

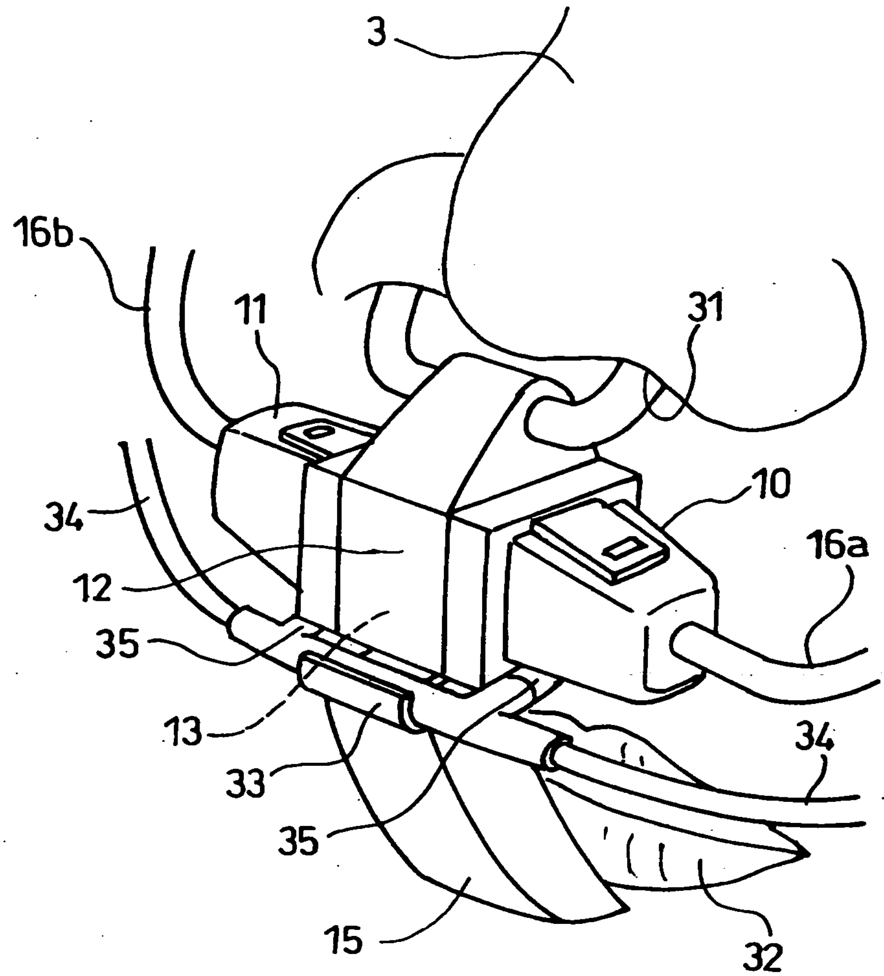


(b)

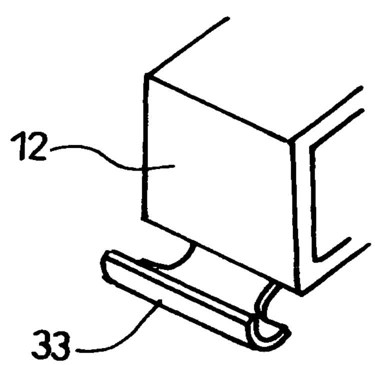


【図９】　Fig. 9

(a)

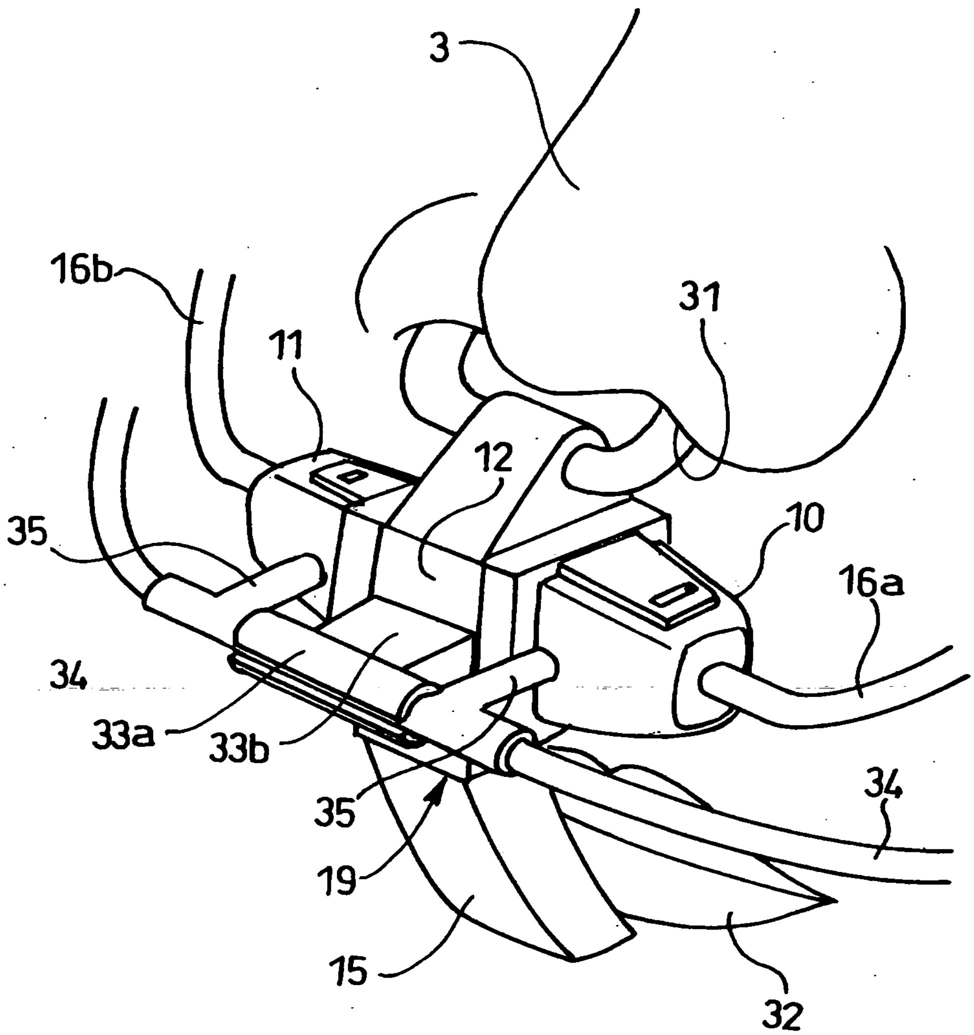


(b)

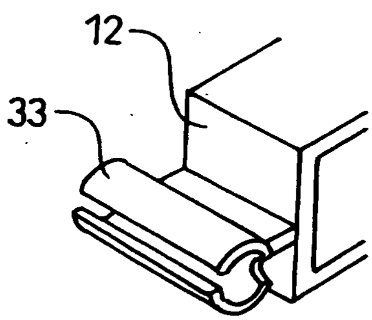


【図１０】 Fig. 10

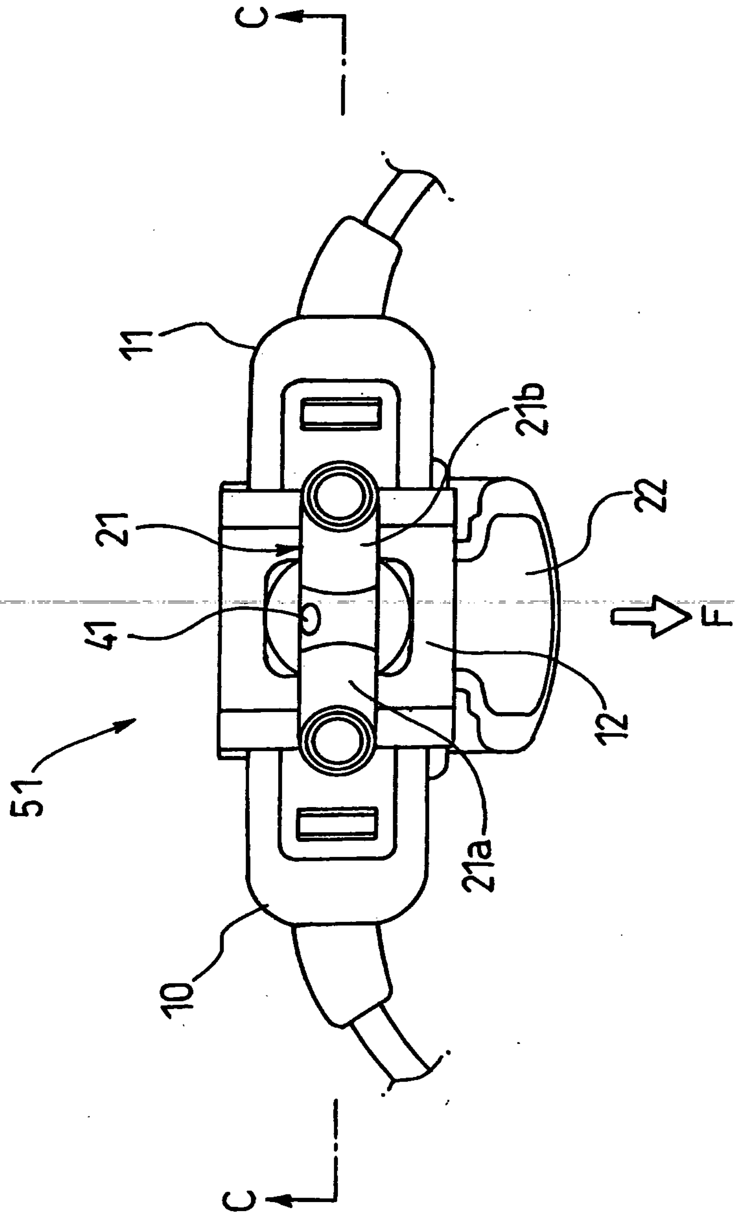
(a)



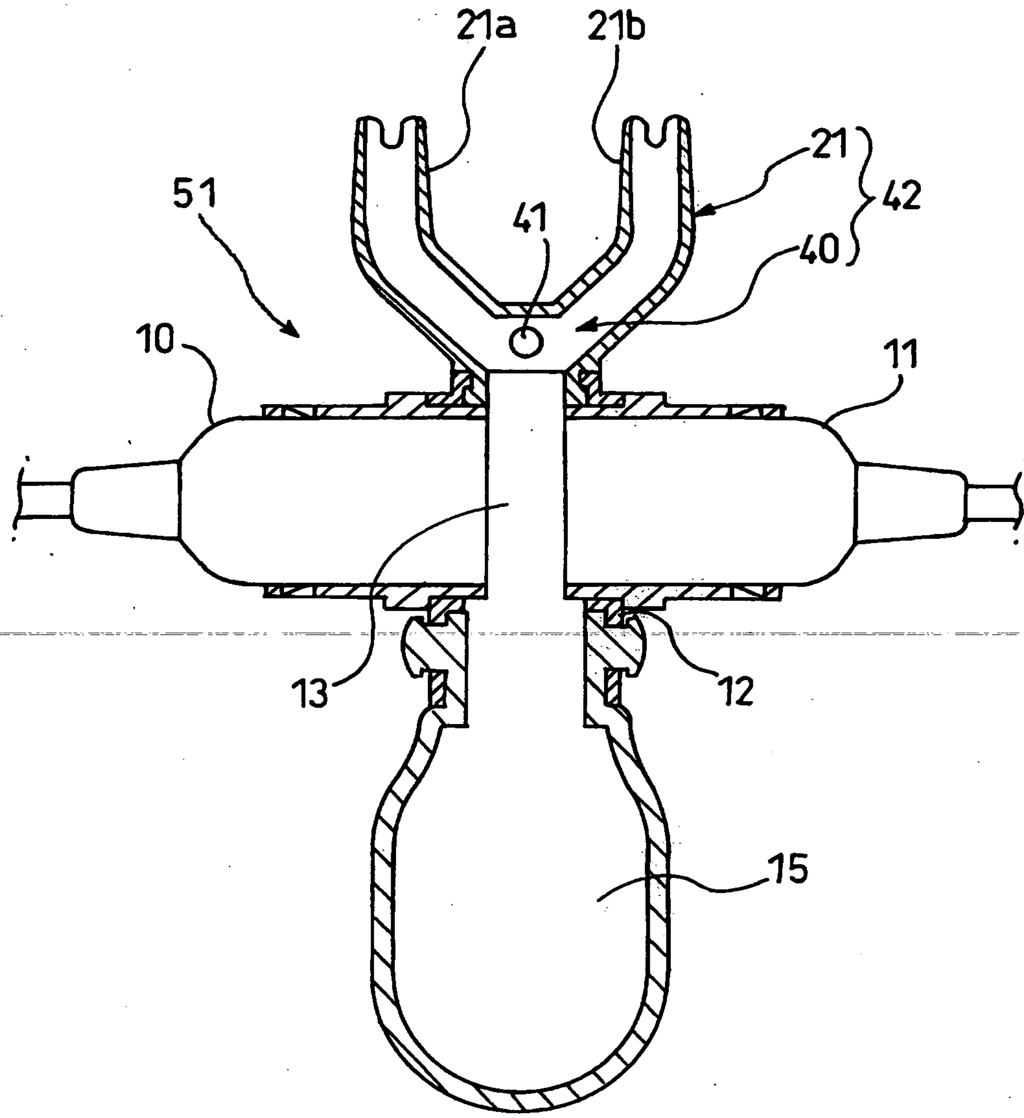
(b)



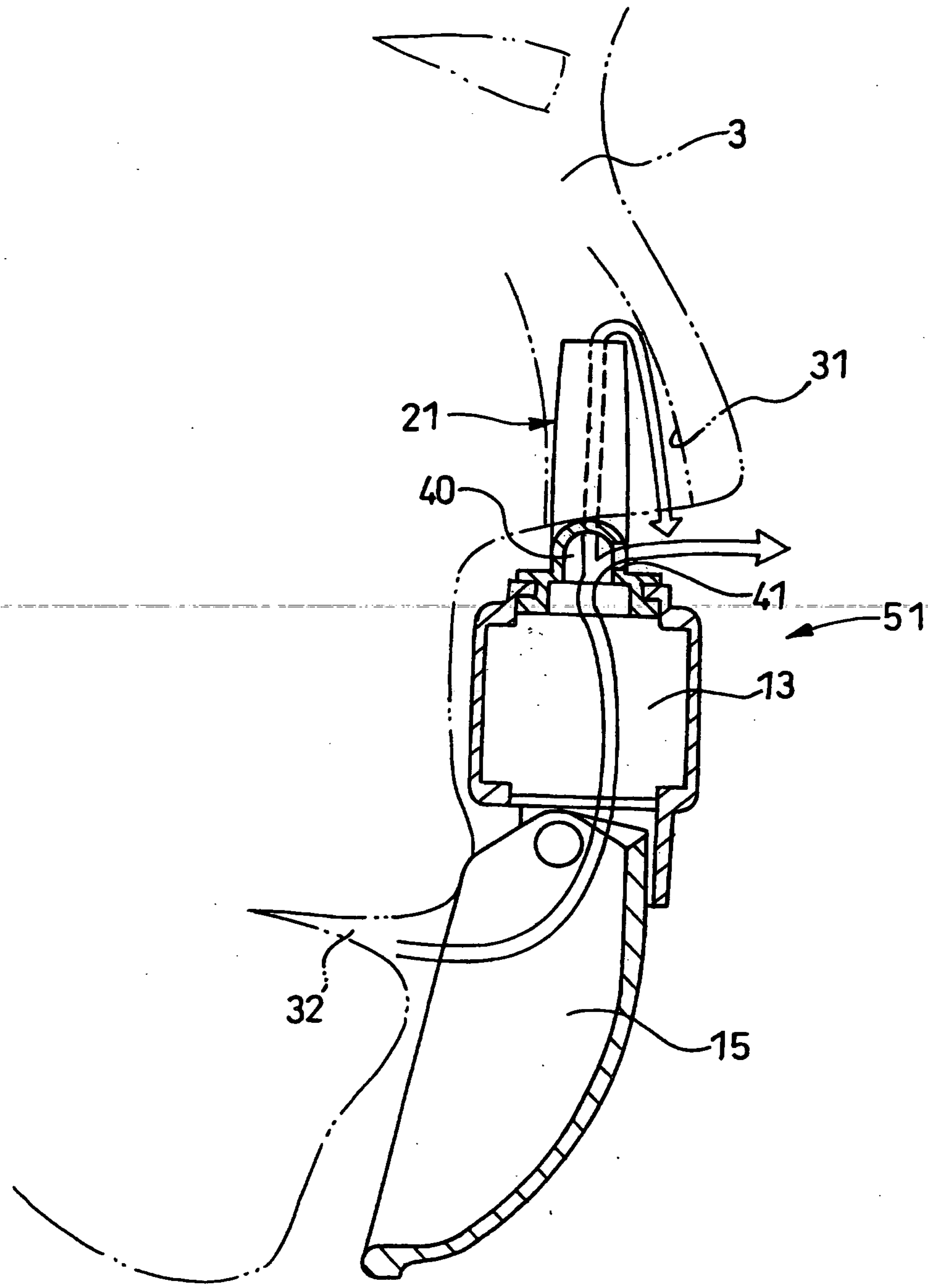
【図１１】 *Fig. 11*



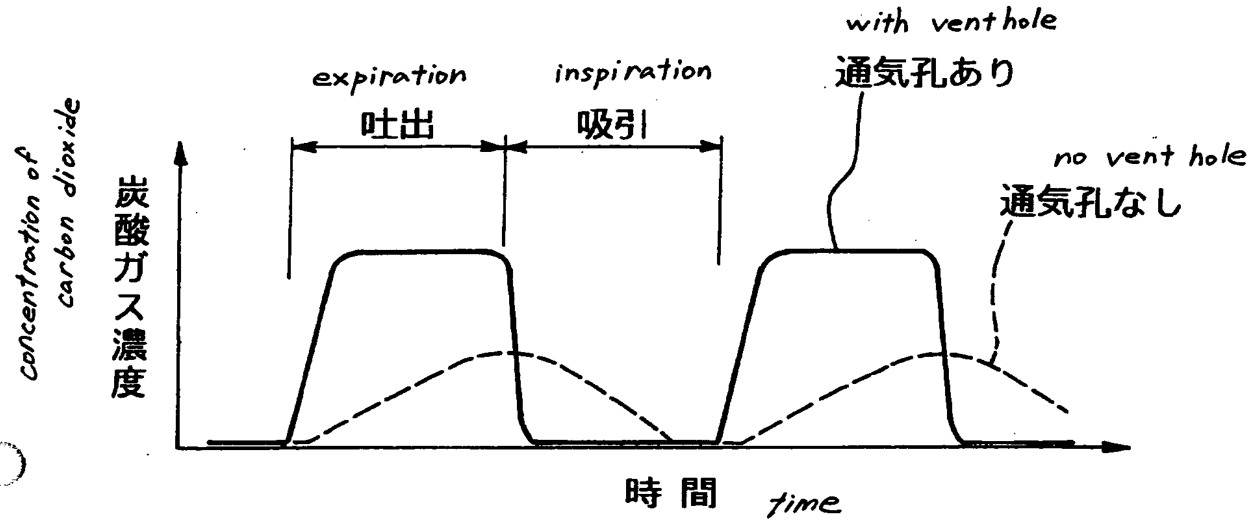
【図１２】 Fig. 12



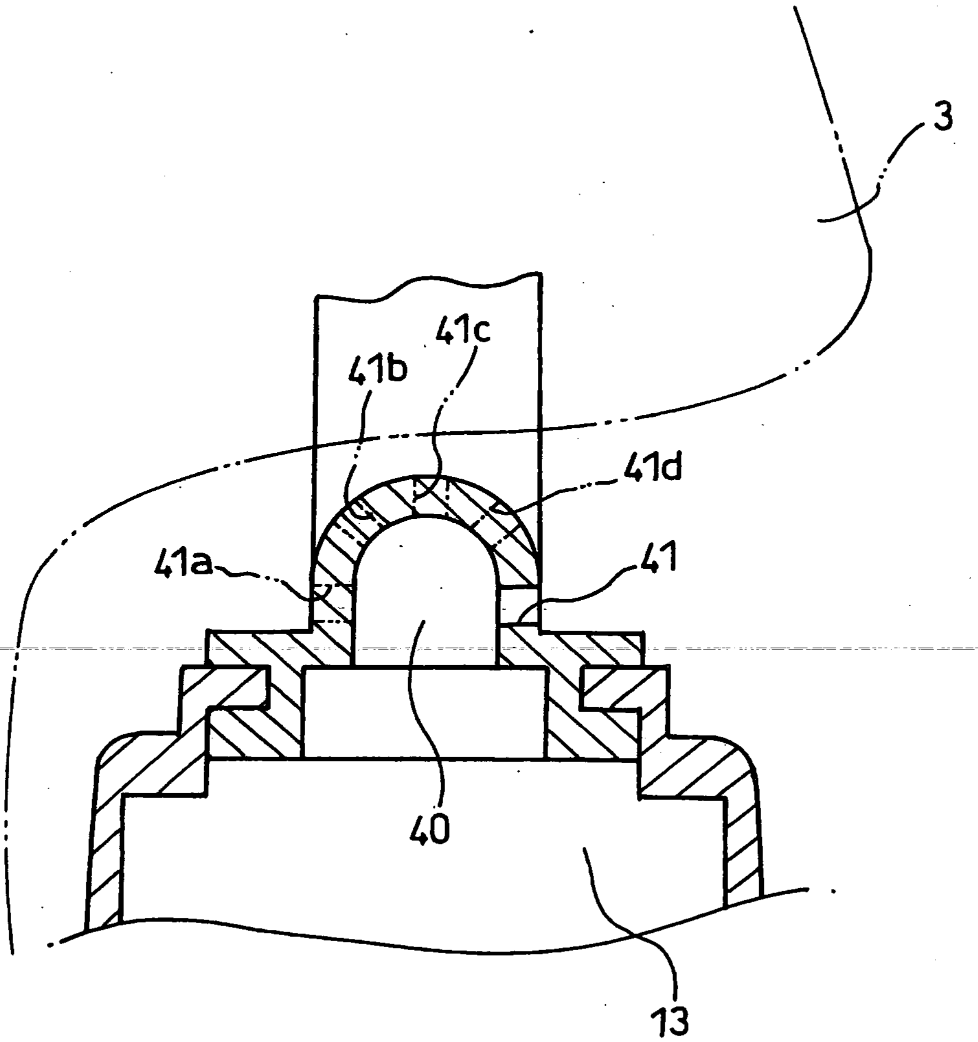
【図１３】 Fig. 13



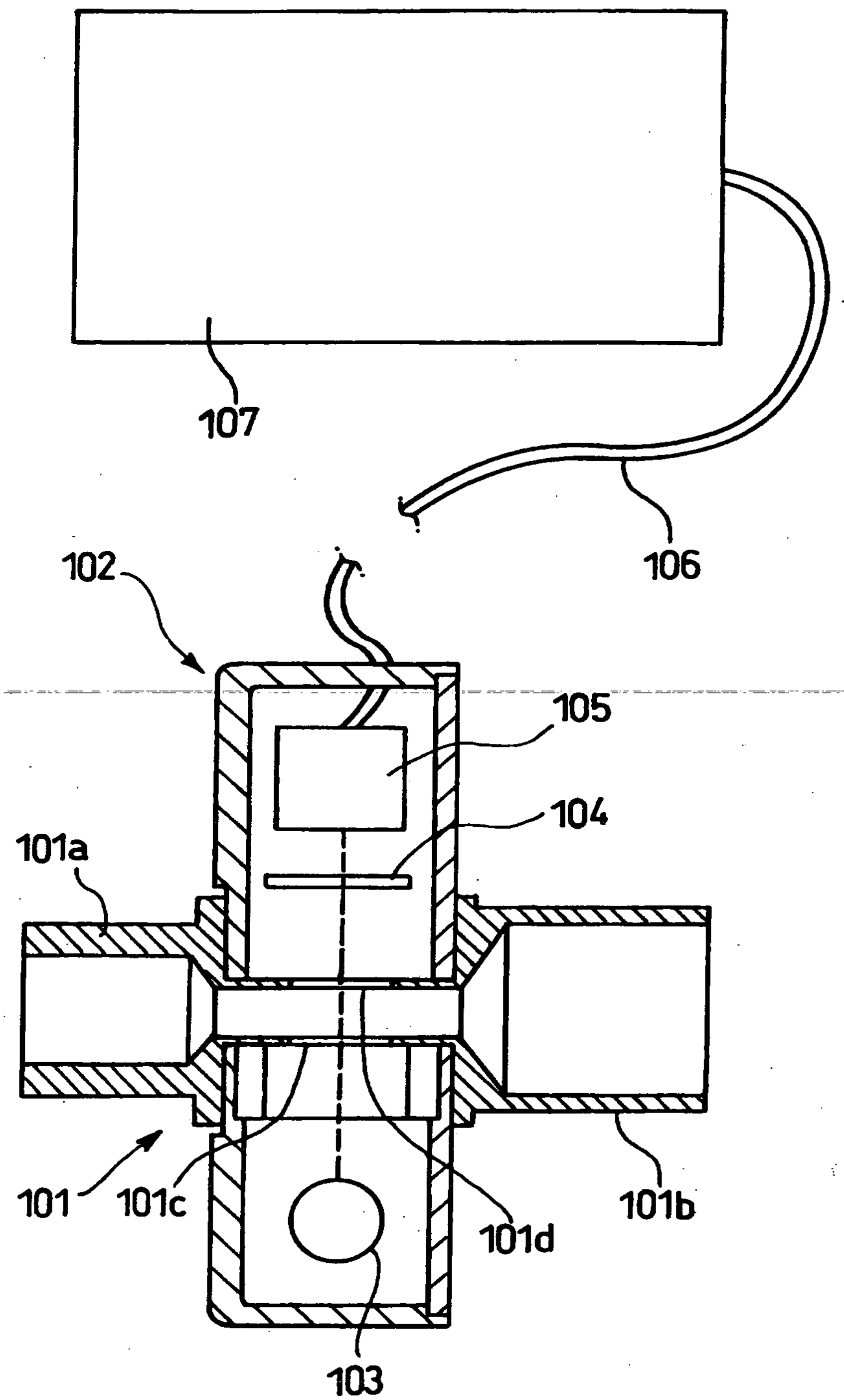
【図１４】 *Fig. 14*


with vent hole
通気孔あり
expiration
吐出
inspiration
吸引
no vent hole
通気孔なし
concentration of carbon dioxide
炭酸ガス濃度
時間
time

【図１５】 Fig. 15



【図１６】 Fig. 16



【図１７】 Fig. 17